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INDIAN TEA ASSOCIATION

SCIENTIFIC DEPARTMENT

TOCKLAI EXPERIMENTAL STATION

ANNUAL REPORT—1944



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BY THE DIRECTOR, TOCKLAI EXPERIMENTAL STATION

The report for the year can be no more satisfactory than that for 1943 for the activities of the department have continued to be controlled by the conditions imposed by the war. It has been impossible to initiate new experiments and it has been possible to maintain only with great difficulty the experiments in being; especially is this so with the field experiments on account of the shortage of labour.

The buildings have been kept from deterioration but earthquake repairs have not been generally effected as materials are not only costly but very difficult to obtain.

Buildings : Bungalows Nos. 1, 2 and 3 have however been restored and are occupied by the U. S. A. hospital staff. Bungalow No. 6 has been derequisitioned and has been occupied by Mr. Macgregor.

Delay in repairing the buildings is advisable until such time as the future plan of work for Tocklai has been defined.

Mr. Tunstall has remained with myself at Tocklai. Mr. Macgregor rejoined for normal duty on the 1st. September. Mr. Benton has remained in Darjeeling.

Staff :

Mr. Harrison has continued on "Project Work". Drs. Roberts, Wight, and Woodford and Mr. Winter are still in military employ.

Mr. Gilchrist has returned to civilian duty and it will be possible to recommence selection of tea bushes for clones on the basis of the character of the made tea. He however arrived too late for work to be undertaken in 1944.

Further work has been attempted on the chlorophyll content of the leaf but lack of apparatus and chemicals made a continuation of this work difficult and it has been postponed for the time being. The manufacturing experiments have

Chemical : shewn that an increase in total nitrogen content of the leaf results in a lowering of the quality of the made tea. The increase in nitrogen content of the plucked shoot is proportional (a linear function) to the increase in nitrogen supplied as manure. It is therefore of importance to study in detail the nitrogen content of the leaf. Experiments are in progress but at present are in no more than an initial stage. It is however of interest to note that the bushes within a clone show significant differences in nitrogen content. This suggests that whilst the general appearance of the bushes

seems to be identical yet differences in chemical composition occur which may effect the quality of the made tea. The matter requires study.

Standards have been given for commercial tea but it was not known whether such standards were suitable for tea dusts.

An examination was made of 240 samples of tea dust drawn at random from consignments sent to market in Calcutta. The data allows of recommendations for standards being made.

Routine analyses of manures and soil samples were carried out. A sample of quinine sulphate was submitted for examination and found to be mixed with approximately 25% of starch.

An experiment on Red Rust *Cephaleuros parasitica* has shown lighter plucking allowing new leaf to remain on the new year's stems during the plucking season and has resulted in improvement. Improvement in the appearance of the bush has been noticed also on a plucking experiment at Tocklai (Rajghur). Leaving the bushes unpruned for one year when combined in subsequent years with leaving a new leaf during the plucking season seems also to have effected an improvement.

Mycological :

I wish to record our thanks to Messrs. The Jorehaut Tea Co., Ltd, for their co-operation in carrying out the experiment.

The replanting of areas that have long been under tea where the soils are impoverished is likely to result in considerable damage to young plants by red rust unless given lighter plucking and the proper application of sprays.

The establishment of clonal areas on a scale that allows of satisfactory comparison of the characteristics of the bushes so raised both in respect of cropping capacity and quality of the made tea is needed and 15,000 cuttings have been taken during the year from 25 selected bushes giving an average of 600 cuttings from each individual bush. The clones finally selected will provide the reservoir of materials for raising new seed baris.

Botanical :

With the object of providing an improvement to the present system of raising a seed bari an experiment was commenced in the Hoolungaphar Forest Reserve with 4 multiclonal baris utilising representatives of 36 clones. Unfortunately in April a military unit found the cleared areas in the forest a suitable camping ground and destroyed one of the baris. The responsibility has been acknowledged by the military authorities and compensation will be paid. But this does not overcome the delay that has been imposed upon a very important experiment. Fresh materials will have to be obtained for the replanting.

The vigour of the bushes of a clone is a factor of importance and an experiment to obtain some information of this was started in 1941. The plants have now been dug

up and examined. The resulting data needs careful statistical study which it has not been possible as yet to complete.

The cross pollination of selected clones has been continued and some 3100 pollinations made between 19 crosses. The seed obtained will be planted and the progeny examined for further elimination of undesirable clones.

Mr. Benton has during the year visited a number of tea estates in the Darjeeling district in order to study manufacturing conditions. In co-operation with managers

Bacteriology : of Estates experiments have been carried out and it has been possible to make alterations and improvements of considerable value.

An experiment to compare plants raised by cuttings with those from seed shew no
Agriculture : apparent difference in the general good healthy appearance of the bushes. The plants have been pruned to about 20/18 inches and will be in regular plucking in the coming season.

The raising of plants from cuttings is now so successful that in-filling in the experimental plots is now being done with plants from cuttings taken from bushes in the plots.

Experiments on estates have had to be largely discontinued although some are being continued. Our special thanks are extended to those Managers who are carrying on those field experiments that have not yielded their full quota of information. The difficulties of carrying on experiments successfully is fully appreciated. The experiments that have been discontinued have in the majority of cases yielded all the useful information that they are likely to give and their discontinuance would have been effected under normal circumstances.

Some experiments have been discontinued because Managers found it impossible under restricted staff conditions to ensure the accuracy of the results. We are much indebted to all those who no longer are carrying on experiments for their ready co-operation and it is hoped that initiation of new experiments will be possible in the not very distant future. The experiments carried out on estates by the Managers is most important for it brings scientific and industrial thought into close association for practical purposes.

The experiments with bulk organic manures have now been carried on for some time and details of some of these experiments are given in the Agricultural section of this report. The results clearly shew the value of the bulk organic manures and that for the same application of nitrogen it is much less efficient than that of the inorganic manure such as Sulphate of Ammonia. The efficiency compared with inorganic manure as 100% is :—

At Allynugger, the Indore Compost 43%, the Dacca compost 48%, the unfermented materials used for making Dacca compost 68%, Animal Meal 83%. At Champarai, the compost 58%, and at Gandrapara 40%.

Whilst these data shew the low efficiency of the compost yet the commercial value of such manures must be judged by cost of the increase in crop resulting from the manuring. This depends upon the cost of collecting the raw material and preparing the compost and varies greatly from garden to garden. This must be determined for each and every garden. It consequently will serve no useful purpose to discuss that aspect in this report.

The results that have been obtained from experiments on estates to determine the interaction of shade trees with manures is interesting and whilst the results so far obtained must not be considered as final, yet at the present time when the efficient use of manures is so important owing to the shortage in supply it is thought advisable to give the results up to date, as they may help towards the better use of available manures.

MYCOLOGICAL BRANCH REPORT FOR 1944

STEM DISEASE

BY A. C. TUNSTALL, MYCOLOGIST

Sun-scorch—Specimens of dying young plants received from time to time frequently show the effects of sun-scorch at their collars. Such plants especially those planted in the rains should have their collars protected from the August and September sun either with a bamboo chatai placed around the stem or some other device. Boga medeloa planted between the lines will be helpful.

Black rot—Some bushes in spite of being treated at different times with different spray fluids such as Burgundy mixture, Perenox, etc., were affected to some extent year after year. Although the spraying checked the progress of the disease considerably it does not completely eradicate the fungus from all the bushes. It was probable that the fungus was harboured somewhere on the bushes concerned. It was already known that the fungus passed the winter season in the cracks and crevices of the tea stem but the manner of its existence was not established. As a rule such fungi live through the winter season either by forming special resting devices known as sclerotia or by parasitising other hosts. With a view to discovering the resting stage of the disease specimens were collected every month and carefully examined. Sufficient material for examination was obtained also from some affected bushes at Borbhetta and at intervals from local gardens.

The fungus was traced down on the surface of the branches from the current season's growth to varying distances between the last pruning level and the soil surface, the maximum distance was found to be 20" (almost at the soil surface). In all the cases the growth appeared to start from a hole formed on the branches. Microscopic examination of the affected current year's growth revealed the presence of the fungus in the primary bark tissue but no sclerotia were found till the 2nd week of September. By that time the fungus invaded the whole of the primary cortex and in the tissues adjoining the cracks (formed prior to the shedding of the primary bark) initiations of sclerotia were observed as groups of round to oval, colourless cells. A few isolated sclerotia about 100 across were also found in the cracks in some places. Camera lucida drawings were made from these. The fungus, *corticium morsum*, was never found to penetrate beyond the primary bark. Microscopic examination of specimens collected in the middle of October showed that the fungus penetrated the primary bark wherever it found an opening and formed sclerotia mostly in the tissues adjoining the cracks with a few in the open at the bottom of the cracks. They were not noticed on the undamaged surface of the bark. The size was always microscopic. At first they were colourless but by the middle of November some of them turned slightly darker in colour. They took the shape of the bark cells in most cases except those developing in the openings. The latter were spherical to ovoid in shape. The biggest sclerotium found measured 263 x 145

In the middle of December the sclerotia were found to be of all shapes and sizes, mostly elongated and connected to one another, slightly dark coloured and with two thirds of their cells filled with a granular substance. The mycelium on the surface of the branches was slightly dark coloured and was probably dead. Wherever the mycelium happened to pass over a crack in the bark, the tissues of the primary cortex to some distance on both sides of the crack were full of sclerotial bodies.

Experiments are being carried out in a neighbouring garden and at Tocklai with a view to killing the sclerotial bodies by painting the bushes thoroughly with a fungicide which penetrates readily.

Treatment of new clearances—Red rust very frequently causes considerable loss on replanted areas. The benefit of spraying young plants with 5% Perenox in the cold weather has already been demonstrated in earlier experiments. An experiment was designed in 1941 to ascertain the effect of various treatments on tea replanted in 1935 at Katonibari Tea Estate of the Jorhat Tea Company. This was carried out with the co-operation of the Manager, Mr. L. Wilson, and Mr. N. C. Borbora, the Scientific Assistant of the Jorhat Company. 48 plots of 100 bushes each were marked out, and the greatest length and breadth of each bush recorded annually from December 1941.

Pruning—24 of the plots were pruned each year and the other 24 plots were left unpruned in December 1941.

Plucking—All plots were plucked to the janum but 12 plots in each of the above series were given additional growth by allowing a leaf to remain above the janum in July and again in August each year. Thus there were 12 groups of 4 plots of each pair of the above pruning and plucking treatments.

Spraying—One plot in each of the above mentioned groups was sprayed with 3% Perenox in December, one in April and one in July. The remaining plot was unsprayed.

The treatments were randomised and continued until 1944. In 1944 all plots were treated alike. Plucking was to the janum throughout the season and no spraying was done. The crop was recorded in this year.

The results clearly show that leaving unpruned for one year (Dec. 1941) has increased both yield and spread. It also had a very significant effect in reducing the number of vacancies in subsequent years. The leaving of one leaf above the plucking level in July and again in August each year benefited the bushes similarly. Bushes left unpruned one year and allowed the extra growth referred to gave an increase of 14% over those having neither of these advantages.

The spread of the bushes on the sprayed plots was significantly greater than that on the unsprayed once but there was no significant difference to be attributed to the

time of the year the application was made. As July spraying requires much more solution than December it is probable that it would be more profitable to use .5% Perenox in December than .3% in July. It was noticed that the plots sprayed in December had significantly fewer vacancies than the unsprayed ones. It was observed that the best results from spraying were obtained in the plots that had been unpruned for one year and also had the extra leaf left in July and August.

It is interesting to note that there was a very high degree of correlation between the spread of the bushes and the yield in the case of the pruning and plucking series. There was no significant correlation between yield and spread in the figures for the spraying series. This suggests that the spraying had altered the yield per unit area of plucking surface. This was further investigated by reducing the figures to crop per unit area. It was then seen that leaving unpruned for one year was associated with a greater crop per unit area while the leaving of the extra growth during the season tended to reduce the crop per unit area. The effect of the spraying was inconclusive in this connection.

ADVISORY BRANCH REPORT FOR 1944

BY N. M. MACGREGOR, SENIOR ADVISORY OFFICER

Experiments on Commercial Gardens—Owing to the war many of these experiments have had to be closed down entirely while on others the plots have been plucked unmanured and a measure of the residual effect of the manures has been recorded. One or two of the more recent experiments have not been referred to in print and deserve mention here.

The Interaction between shade and inorganic nitrogen—On Rajmai and Behora, experiments were carried out for 4 years in which the shade was removed from alternate blocks. In both experiments the results confirm the strong negative interaction between shade and nitrogen found at Borbhetta and referred to in last years report.

Rajmai

Shade, Mature Al. Stipulata, 40 ft. apart.
Plot yields expressed in mds. of pucca tea per acre.

	No Nitrogen	Nitrogen (SOA) @ 40 lbs. per acre	Increase from Nitrogen	
No shade	6.55	10.78	4.23	} Significant increase from Nitrogen 0.66
Shade	10.93	13.41	2.48	
Increase from shade	4.38	2.63		
Significant increase from shade		1.88		

Behora

Shade Immature Al. Stipulata, 55 ft. apart.

	No Nitrogen	Nitrogen (SOA) @ 60 lbs. per acre.	Increase from Nitrogen	
No shade	7.79	14.73	6.94	} Significant increase from Nitrogen 1.33
Shade	10.52	16.00	5.48	
Increase from shade	2.73	1.27		
Significant increase from shade		2.14		

In this last experiment, the shade is not so dense as at Rajmai or Borbhetta and consequently its effect is less marked. This is reflected in the small increase resulting from shade on both manured and unmanured plots and also in the little difference which shade has made to the effect of the nitrogen.

Both experiments confirm that we may expect to get about 1 maund of extra tea from 10 lbs of nitrogen on unshaded areas, and less on shaded areas according to the density of the shade.

Interaction of shade with organic nitrogen—The three experiments mentioned above deal with the interaction between shade and inorganic nitrogen but that at Behora deals also with organic nitrogen applied in the form of compost.

Behora

No Nitrogen		Compost N at 84 lb yearly average	Increase from Nitrogen	Significant increase from Nitrogen
No shade	7.79	10.38	2.59	1.33
Shade	10.52	11.19	0.67	
Increase from shade	2.73	0.81		
Significant increase from shade		2.14		

The increase from compost on the unshaded areas, though low is not unexpected and agrees with results obtained elsewhere, but the negligible effect on the shaded areas is extremely disquieting. This result is supported by an experiment at Gingia Tea Estate where applications of eupatorium under shade have failed to give any increase, and by another experiment at Halem where cattle manure has failed on a shaded area. This failure of bulk organic manure under shade is not universal and on a second experiment at Halem similarly shaded, response to cattle manure has been recorded. The possibility however that no benefit may be derived from bulk organic manures applied to shaded areas should be constantly born in mind particularly at the present time when so much of the nitrogen applied to tea must necessarily be of an organic nature.

Potash and Phosphate. Possible Interaction with shade—The results obtained from dressings of potash and phosphate on the many N. P. K. experiments put down by Mr. Cooper have been confusing, sometimes one has proved beneficial and sometimes the other, while sometimes both give a beneficial effect when applied separately but a detrimental effect when applied together. Again we may quote the Behora experiment which seems to throw some light on the question.

(Behora)

	Potash	Phosphate	Potash and Phosphate
No shade	1.24 mds. gain	0.5 mds. loss	0.89 mds. loss
Shade	0.54 „ loss	1.6 „ gain	0.16 „ gain

The significant difference is 2.30 so we may regard these figures only as indications, nevertheless the possibility that both potash and phosphate will react very differently on shaded and unshaded areas is interesting, and would certainly explain why such diverse results were obtained from the N. P. K. experiments set out as they were on shaded, unshaded and sparsely shaded areas alike.

Forms of Nitrogen and their residual effect—Most of the experiments dealing with organic forms of nitrogen have now been terminated, and call for no amendment in the findings as published in Memoranda No. 6 and No. 11, except as quoted above, namely that the effect of bulk organic manures may be so much reduced under shade as to render them almost valueless.

A very typical example of the action of organic manure compared with sulphate of ammonia on an unshaded area, is to be found in the Allynugger experiment which is recorded for the full term in the following table :—

(Allynugger). Increase of manured plots over check plots in mds. per acre.

	Inorganic mxt.	Indore Compost	Dacca Compost	Unfermented Dacca Compost	Animal meal.	Sig : effect
Mean yearly dressing of N	78	84	78	82	84 lbs	per acre
1936 no manure	0	-0.03	-0.01	0.06	0.01	0.1
1937 manured	0.60	0.06	0.21	1.01	0.96	0.5
1938 manured	1.87	0.74	0.92	1.55	2.31	0.6
1939 manured	2.26	0.86	1.04	1.61	2.77	0.6
1940 manured	3.45	1.42	1.39	2.64	3.71	0.9
1941 manured	5.28	2.36	1.90	3.20	4.48	1.05
Total increase from manuring	13.46	5.44	5.46	10.01	14.23	
1942 Nil	5.23	2.78	2.27	3.36	3.51	0.98
1943 Nil	4.08	2.23	1.96	2.78	2.36	1.00
1944 Nil	0.15	0.33	0.39	0.36	0.34	0.39
Total residual effect	9.46	5.34	5.62	6.50	6.21	

These figures illustrate :—

1. The relative efficiency of the manures under experiment.
2. The slow rise in crop brought about by annual dressings of manure.
3. The sudden drop which follows cessation of manuring, falling to an insignificant increase in the third year.
4. The failure of composting to increase the beneficial effect of bulk organic manures.
5. The residual effect of sulphate of ammonia is greater than the residual effect of organic manures, including animal meal.

The corresponding results from 2 other experiments which have been carried out to measure the residual effect of bulk organic manures are given below in the abbreviated form :—

Manured for		Increase during manured period from nitrogen as		Residual period	RESIDUAL EFFECT	
		S. O. A.	Compost		S. O. A.	Compost
Champarai	6 years	17.35	9.05	2	3.28	2.89
Gandrapara	4 years	16.68	6.14	4	6.67	3.18

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